

A Study of Supply Chain Management for Sustainable Solid Waste Plan in Perhentian Island, Terengganu

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Abstract— Solid waste management is a serious environmental issue for marine park islands in Malaysia. With the rapid growth of non-systemic solid waste management problems generated by the tourism industry. The amount of waste generated by massive visitors is a difficult problem in small islands as it is usually produced within a short period of time and adds to the existing waste management problems. This study is aimed at identifying the sustainability level of solid waste management in Perhentian Island, Terengganu. Therefore, this study proposed waste management plans for Perhentian Island in order to achieve sustainability of solid waste management in Small Island. Inefficient solid waste management will not only cause a deterioration in tourist arrivals to the island but it also has a negative impact on the quality of the Perhentian island environment. The study using qualitative approaches, in-depth interviews with chalet operators and Besut district Council officials in relation to the management of solid waste management on the island. The study found that integrated recycling program approaches and composting methods were seen to be more efficient for use to ensure sustainable solid waste management in Perhentian Island.

Keywords— sustainability, solid waste, Small Island, management, recycling, composting.

1. Introduction

Solid waste management in small islands is a major issue facing by local authorities in Malaysia. The situation is also faced by local authorities in Terengganu which has five islands of marine parks and are often the focus of tourists. Among the marine parks in Terengganu are the islands of Perhentian, the island of Redang, Lang Tengah Island, Tenggol Island and Kapas Island. Solid waste management systems in all marine park islands in Terengganu are still inefficient and environmentally friendly. Every year most of Resorts Island in Malaysia are experiencing an increase in tourist arrivals until there is an increase in the amount of solid waste [1, 2]. The garbage

collection system is categorized as the primary basis and is identified as one of the key issues faced by local authorities in resort islands. The study also found that Tenggol Island and Lang Tengah still have no organized solid waste collection system [3-10]. Most of the waste is self-propelled by resort owners or with the method of burning waste collected on the island. Challenges faced by Local Authorities in resort islands are less concern of awareness among local communities to contribute in recycling and composting programme. Various activities have been carried out by the authorities on the island community but the activities carried out are not prolonged because of their own attitude that they do not want to change. Exposure to recycling and food waste composting programs was conducted and explained but unsuccessful due to lack of awareness and involvement from local communities. Recycling activities on the island are still low due to the lack of buyers of recyclable materials due to high transportation and maintenance costs. In addition, facilities for recycling on the island are still inadequate, especially the provision of recycling bins around the island and this is also a major challenge facing the authorities in addressing the issue of solid waste management in the maritime parks especially in Terengganu [3]. Education background, condition of house, established income were the main factors influencing local communities to contribute in recycling and compost programme.

2. Study Area

Pulau Perhentian has divided with two islands namely Pulau Perhentian Kecil and Pulau Perhentian Besar located within the state of Terengganu where about 11 nautical miles or 21 kilometers from the east coast of Malaysia, in the South China Sea (figure 1). Both islands have been gazetted as a marine park dating back to 1994. The

community placement on the island of Kampung Pasir Hantu with a population of 2, 023 people on Pulau Perhentian Kecil. The majority of the population is involved in tourism activities, which is also a major economic activity on the island. The village is located in the north-east of Perhentian Kecil Island. It is a fishing village and has several public facilities, including the police station, health center, mosque, jetty, and shop.



Figure 1. Perhentian Island

3. Methodology

This study involved respondents' questionnaires consisting of residents of Pulau Perhentian. A total of 106 respondents had been involved in this questionnaire consisting of 56 female respondents while the rest were men with 50 respondents. The questionnaire was made to see the level of people's satisfaction about solid waste collection services and their managers on Pulau Perhentian. This study also involved in-depth interviews with three research informants. Among them are resort management, cleaning contract staff and Besut District Council officials who are directly involved in the management of waste in Pulau Perhentian. In addition, observation methods were also used in this study on solid waste management processes by contractors, including collection, transportation and waste disposal systems to landfills. Secondary data is obtained from the annual report of the Besut district council, the official portal of Besut District Council, as well as journals related to solid waste management. Information and data obtained from

interviews will be analyzed and coded according to the themes set in the study.

4. Results And Discussion

Among several issues faced by Resort Island over the years, increasing waste generation is becoming one of the major problems. In additional, the problems of land scarcity, lack of economic resource and expertise in the field of waste management considerably reduces the waste management potentials in these island. Waste management system in Perhentian Island are under pressure because of increasing population, changing patterns of consumption and tourism industry. The current system of waste management also seem not environmental friendly and less efficient in term of economic [11, 12].

An increase in the number of tourists visiting Perhentian Island generates more waste which must be disposed of. The disposal methods chosen can have their own environmental impacts; landfills create leachates which can impact water and soil and incineration generates ash and air pollution. Poor disposal methods are particularly problematic for marine environments as a number of marine animals can be impacted by certain types of trash. Prior to tourism on the islands, local residents dealt with their waste through small scale burning and localized composting of decomposable materials. Most of the waste generated was from natural sources on the islands as other materials would need to be imported from the mainland. In more recent years, the lifestyles of village residents have changed and more products are imported which are difficult to dispose of Resort Owner interview.

The poor solid waste management behind the premises of the building and the beach without guardianship and surveillance also affects visual quality and directly affect the tourism industry in the resort island [13-16]. In order to deal with the trash generated by tourists, the Perhentian island operate a trash removal service which collects trash from centralized points and disposes of it on the mainland. This is a mandatory service and there is a fee for this which is billed to each of the resorts. However, it was not clear whether there was a difference in amount for the size of the resort; each resort operator when asked about this was not sure. Some resorts said they were billed through their tourist license. It was suggested that if you do not

pay the trash fee, you do not get your license to operate. Many operations are refusing to pay the maintenance fees and continued to indiscriminately throw their garbage into the sea.

The trash collection service is only operated during peak season, usually around mid-February to mid-September; it cannot operate during monsoon season or bad weather as the waves are too high (boat operator). The trash generated during the off-season is considerably less due to the limited number of tourists on the islands, but what is generated is usually burned. The difficulty comes when the services stop operating, but tourists are still arriving or workers are still on the islands. In

these situations some resorts will ferry their trash back to the mainland, others including the local villages bury or burn it behind their backyard. (Besut District Council Interview). Consequently, illegal dumping or backyard burning of wastes becomes a common waste management practice in many Small Island Developing State (SIDS). Food waste is the most abundant solid waste that is more than 72 percent in Perhentian [17-23], (Table 1). Thus, to address the problem of solid waste in the island as well, existing resorts are encouraged to compost and recycle programme. It's seen more practical and relevant in achieving sustainable solid waste management at Resort Island.

Table 1. Waste composition in Perhentian

Categories of solid waste	Weighted average (kg/day)	Weighted average (%)
Food waste	858.75	71.73
Paper	69.14	5.77
Wood	18.64	1.56
Aluminium	96.52	8.06
Plastic	60.65	5.07
Glass	32.08	2.68
Garden waste	62.45	5.13

4.1 The Level of Satisfaction In Solid Waste Management Among The Community

Table 2 shows the respondents' socio-demographic analysis of the questionnaires distributed to the communities in Pulau Perhentian, Terengganu on

solid waste management. A total of 106 respondents had been involved in this questionnaire consisting of 56 female respondents while the rest were men with 50 respondents.

Table 2. Perhentian Island Household Profile

Category	F	%	Category	F	%
Gender			Income (monthly)		
Female	56	52.8	100 – 999	29	27.4
Male	50	47.2	1000 – 1999	49	46.2
			2000 – 2999	9	8.5
Age			3000 – 3999	10	9.4
10 – 19	10	9.4	4000 – 4999	1	0.9

20 – 29	32	30.2	5000 – 5999	8	7.5
30 – 39	22	20.7			
40 – 49	20	18.9	Number of household		
50 – 59	11	10.4	1-3	37	34.9
60 – 69	8	7.5			
70 – 79	3	2.8			
			4-7	48	45.2
Nation					
Malay	103	97.2		12	11.3
Bumiputra Sabah	1	0.9	8-11		
Siam	2	1.9			
			Occupation		
Marital status			Public servant	10	9.4
Unmarried	30	28.3	Self-work	8	7.5
Married	74	69.8	Business	20	18.9
widow	1	0.9			
divorced	1	0.9	Boat driver	18	17.0
			Boat maker	4	3.8
Education background			Housekeeping	3	2.8
No formal education	6	5.7			
Primary school	25	23.6			
Secondary school	67	63.2	Fisherman	11	10.4
Higher education	8	7.5			
			Security officer	2	1.9
			Housewife	23	21.7
			Others	7	6.6

The age range of respondent in Pulau Perhentian is 20 years old up to 39 years (fig. 1). Here it is clear that the community in Pulau Perhentian is among the youths who are still actively working. The majority of communities in Pulau Perhentian also comprise Malays with 97.2% or 103 respondents, followed by bumiputera Sabah 0.9% or 1 respondent and Siam with 2 respondents or 1.9%.

Most communities in Pulau Perhentian have families and respondents' education level up to 63.2 percent. Community income levels range from RM 1000 to RM 5999 per month. The study found that most of the communities in Perhentian Island works as resort operators, fishermen, merchants, tourists and resort workers. The community in Perhentian Island mostly settled in one home with

at least four (4) families. Here shows that there is a density in a house that also affects the quality of family life in the village of Pulau Perhentian. Overall analysis results can be seen in table 2.

4.2 The Level of Satisfaction of Respondent with Waste Collection System in Perhentian Island

The survey found that (62.3%) respondents stated that the garbage collection system on the island of Perhentian was sufficient. While only 33% think the garbage collection system is still inadequate (Table 3). The study found that garbage collection systems using boat trips are still inefficient so that there are communities and chalets operators who conduct open burning at the back of their respective chalets and resorts. This situation has affected the landscape and visual quality of the island. This issue is also discussed with Solid waste corporation Terengganu (SWcorp) but the problem will continue if the population has no awareness and accountability towards the protection of the island treasures. In addition, the lack of supervision and monitoring from local authorities also affects this problem. While the island's recycling facilities are still inadequate, especially the provision of recycling bins around the island and this is also a huge challenge in addressing the issue of solid waste management on marine park islands.

Table 3. Respondent's satisfaction level

Waste Collection System	Frequency	Percentage (%)
satisfaction	66	62.3
Unsatisfactory	35	33.0
Not sure	5	4.7

The situation of the garbage collection system carried out by the Besut District Council can be seen in Figure 2. The community is dissatisfied because there is a dumping pile up to 4 days left on the edge of the coast, especially in the monsoon season. The challenge is the inability of the entrepreneur in managing solid waste and recycling. Exposure to food waste composts has been carried out and explained but unsuccessful because at these composts they produce a bad smell and take a long time to get the end of products. The

island is still short of buyers of recyclable materials due to high transport costs. In addition, the facilities for recycling on the island are still inadequate, especially the provision of recycling bins around the island and this is also a major challenge in addressing the issue of solid waste management on marine park islands.

Community participation is critical to the success of any recycling programme. The recovery of large volumes of the high quality recyclables material depends on citizen involvements [18, 19]. The study also found that there is no separation waste system at households and resorts in Perhentian Island. According to Ministry of Housing and Local government in Malaysia almost 60% to 80% of the budget has been spent for solid waste collection particularly in residential areas. Thus, an effective implementation of the separation of waste at source requires continuous effort from government and non-governmental organizations to create an effective education programme which able to educate people to participate in recycling activities and raise the awareness of environmental protection as a whole.



Figure 2. The ship transporting the waste to be disposed of Pulau Perhentian in mainland

5. Discussion

National conservation strategies have established that sustainable tourism principles should take into consideration aspects of conservation and sustainability of natural, social and cultural resources and waste reduction to avoid cost recovery [5, 6]. The Commonwealth Secretariat, 2000, has identified that the characteristics of small

islands such as isolated and distant lands, openness and exposure to natural disasters and environmental changes, poverty, limited capacity in the public and private sectors are a challenge in developing an island. The population growth projection in Perhentian Island is expected to increase the production of municipal waste. High growth in the tourism industry is not the main reason for the increase in residual income here; On the other hand, the focus is on increasing existing capacity. However, the volatility of tourist arrivals affects the collection, transportation, treatment and residual capacity resulting from tourism activities [20, 21].

Best solid waste management has various aspects of social, political, environmental, economic and technological [22, 23]. Managing solid waste requires some basic information such as knowledge of the type of solid waste disposed, the solid waste quantity, where solid waste generation occurs, and the party that generates solid waste and what will happen to the solid waste. In this regard, it is clear that the management of solid waste in Perhentian Island should involve all parties whether local authorities, locals, and tourists. Without the involvement of all parties, the management of solid waste in Perhentian Island will be not achieve the sustainable goal. Integrated solid waste management is very important and needs to be implemented promptly. This solid waste management has undergone a very serious change as solid waste produced by humans is growing and needs due diligence. Integrated solid waste management is not just about controlling the solid waste generated but more importantly how this system is able to provide a level of clean environment and good health to local people and tourists on the of Perhentian Island.

The concept of sustainable development, as noted in the Bruntland report (1987 World Commission on Environment and Development reports), development should be carried out in a way that will not affect the future generation's ability to meet their own needs. This encompasses the concept that we should not abandon the problem that future generations must endeavor (for example, contaminated or unrecoverable land, air and water) and limited resources need to be maintained and preserved. The approach is appropriate in the waste management process. Therefore, the authority's approach to managing waste in Perhentian Island is to ensure that waste handling, treatment and

disposal should be managed eco-friendly to mitigate the long-term effects of waste. Report from the Terengganu State Structure Plan 2015, suggesting the establishment of a moving station for solid waste management. Transfer stations are proposed in major island areas such as Perhentian Island, Redang Island and Kapas Island.

The addition of transfer stations in other resort islands such as Lang Tengah Island and Tenggol Island will be subject to the study of maximum capacity carrying capacity of the islands. These moving stations will collect and compress the waste before being sent to major disposal points. However, detailed studies have to be carried out to ensure that the suitability of the proposed method is appropriate and can address the problem of solid waste disposal in the islands. Therefore, this study proposed waste management plans for Perhentian Island (figure 3). The cooperation with the stakeholders is essential to ensure that municipal solid waste plan works properly and also public participation are the most important to achieve sustainable waste

Figure 3. Sustainable plan of solid waste management in Perhentian Island

This planning plan involves the construction of recycling and composting centers built on the island. The participation of local communities at the Perhentian Island is seen as an important element in ensuring the management of recycling and composting programs with assistance from local governments. This Plan is not only can achieve towards sustainable solid waste in Perhentian Island but also generate income to local communities through recycling and composting.

6. Conclusion

Most small islands in Malaysia face challenges in ensuring sustainable use of natural resources and eco-friendly waste management. The unique social, economic, and environmental features of the small island such as the lack of extensive areas and the scarcity of human resources and financial resources are among the factors of good waste management barrier. This problem is worsening with the arrival of holidaymakers during the holiday season which increases the cost of waste disposal. This makes it difficult for authorities in managing wastes with limited waste management facilities. Hence. A

particular organization or individual should be given full responsibility for implementing the plan as well as reporting on current developments and evaluating whether it achieves the objective or not. Procedures for coordinating the activities of different agencies need to be regulated. The budgets for diverse actions need to be established and it should get the approval of the authorities. Therefore, authorities need to formulate strategies to ensure sustainable waste management efforts can be developed. The role of the public and private is necessary in this effort. To overcome the problem of solid waste disposal in Pulau Perhentian requires involvement from all parties whether local authorities, state governments, federal governments, private parties as well as locals. Without the unwavering support of all parties, what is planned and to be implemented in addressing the problem of solid waste disposal will not achieve its goal.

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